VOL. XIII. NO. 10.—BOTANICAL GAZETTE.—OCT., 1888.

Development of cork-wings on certain trees. I.

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The name cork-wing has been applied to ridges of corky substance extending lengthwise along the young stems of certain trees and woody shrubs. One very prominent example is that of Liquidambar styraciflua, a tree which in the southern states attains a large size, the young branches of which are ridged with this cork formation, so that the tree, when standing leafless, has the appearance of being supplied with a set of troughs to conduct off the water.

This peculiar habit of growth is exhibited by several other species of trees, which, however, differ less in appearance from the ordinary bark-producing tree. Such are certain maples, oaks, elms and a few others. The peculiarity of the Liquidambar tree is that the wings of the lateral branches project mainly from the upper side, thus giving the tree in winter the curious appearance before mentioned. It was with reference to this one-sided growth, together with the large amount of material seen to be expended in what seems a useless appendage, that a brief study of the manner of formation of these wings was undertaken. This led to a similar study of some of the other trees referred to above. In the literature of cork and its development, this peculiarity is mentioned as of sufficient importance to admit of its receiving a particular name, but, so far as I have been able to learn, no special examination has been made of the so-called cork wings as distinguished from other forms of corky projections from the surface of dicotyledonous and coniferous growths. Dr. Carl Sanio, in his work on cork,[1] remarks, with true scientific candor, "It is extremely difficult to study the development of cork wings." Sanio's ability as an investigator and the amount and value of his contributions to botanical science are too well known to require proof here, and as this remark occurs in connection with what he says of the Liquidambar tree, it may be well to explain at the outset that the following results are not given as representing an ex-

[1] Pringsheim's Jahrbücher, 1860. Vol. II. Page 39.

haustive study even of the few species examined, but rather as an introduction to an intended wider and more detailed investigation.

In the whole range of vegetable anatomy there is, perhaps, no other subject about which so much has been written, which still remains so obscurely treated in the ordinary text-book as that of cork formation in general, and more especially of that peculiar process which leads to the formation of bark. One reason for this is, without doubt, the lack of agreement among different authors in the use of the terms referring to the outer growths of woody stems of dicotyledons and gymnosperms. For example, several text-books, written in English, differ in the definition of the term bark, which, though acknowledged to be a general, rather than scientific term, still deserves to be used in a manner to make clear what part of the stem is meant. Another very probable reason is, the difficulty of the subject itself and the fact that each successive author, in writing upon it, introduces new terms and partially modifies the old. Owing to these facts, a summary of the terms used, with their definitions, together with a brief history of the subject, may be allowed before entering upon a description of the work done.

As to its history, it is, perhaps, unnecessary to state that cork was one of the first objects of microscopical investigation, as this was purely accidental. Robert Hooke, about the middle of the seventeenth century, invented an improvement on the compound microscope of that time, and in order to show the importance of his invention, used pieces of cork among other objects. H. von Mohl was the first to publish a description of cork in an article entitled, Untersuchungen über die Entwickelung des Korkes, etc.[2]. In this he showed that the bark owes its origin to the development of cork-lamellæ inside the rind.[3] Rudolf Müller[4] followed him, but his work was limited to the relation of the cork to the other tissues of the rind of deciduous trees. Later, Hanstein,[5] Schacht[6] and Schleiden[7] made various studies in this field. After

[2] Verm. Schriften, p. 212.

[3] *Rind* here in the general sense of German "Rinde," *i. e.*, all that part of the stem outside the cambium ring. Primary rind, those cells of the fundamental tissue of the stem between the epidermis and the ring of vascular bundles. Secondary rind, all the phloem tissue, both of the original vascular bundles and whatever secondary growth may be added from the cambium layer.

[4] Breslau Dissertation.

[5] Untersuchungen über den Bau und die Entwickelung der Baumrinde.

[6] Der Baum.

[7] Grundzüge der Wissenschaftl. Botanik. 3d edition. Page 283.

them came Sanio, who says that the previous investigations have reference mainly to the relation between cork and the other rind cells, and that, while they make clear the meaning of this tissue in the household of cork-building plants, the history of its development, the law governing the succession of cell growth, etc., has not yet received attention. Schleiden had made the mistake of supposing the development to originate in all cases from the epidermal cells. Von Mohl and Hanstein attributed it to the first layer of primary rind cells. Sanio now made a more thorough study of it in reference to this point, and showed that there is no uniformity as to the place of origin of the cork tissue, but that it begins, in some cases, in the epidermal tissue, in others, in the first layer of primary rind cells, or in the second or third layer, and finally it may originate more or less irregularly, deeper in the rind tissues. The layer of cells which take on this activity, beginning to grow and divide, thus forming new tissue, was first named *cork cambium*. Nägeli named it *phellogen*. Sanio showed that from this layer the cells of the cork tissue were cut off toward the circumference; the same phellogen layer could also cut off cells toward the center of the stem, growth proceeding both in a centripetal and centrifugal direction. There was, however, this difference, the cells cut off toward the circumference were more or less corky in nature, while those developed on the opposite side of the phellogen layer became parenchymatic tissue and might contain chlorophyll.

In 1877 von Höhnel[8] took up the subject again with special reference to the chemistry of the tissue, and gave as a reason for his investigations that, up to that time, the question, "What is the suberin of authors?" had not been answered; that there were two principal views on the subject, the one, that suberin is nothing more than a physical modification of cellulose; the other, that it is itself a substance forming an integral part of the wall whose foundation is cellulose. The latter view is fully sustained by his researches. He says suberin is just as distinctly a substance as cellulose or lignin. Farther than this, he shows how it is distributed in the wall and how it may be detected. By these tests he proves that much of the tissue heretofore considered cork consists largely of lignin, that these tissues alternate with each other, the lignin being produced early in the season, the suberin later.

It will be impossible to make clear what follows without

[8]Sitz. Berichte der Wiener Akad. d. w. Nov. 1877. LXXVI. I. p. 587.

an explanation of the technical use of terms as generally agreed upon by different authors on this subject, taking De Bary as authority wherever differences exist. Sanio named the cells cut off from the phellogen toward the center of the stem *phelloderm*, those cut off toward the circumference *phellem;* von Mohl made a distinction between the plate-formed cells, that is, those of short radial diameter, and the longer ones, naming the former cork, the latter periderm cells; this distinction being considered unscientific, inasmuch as both are developed alternately from the same layer. De Bary,[9] who wished to retain the term periderm, determined to refer to this word all that tissue originating from the phellogen layer. So that, as the terms are now used, periderm consists of two kinds of tissue, that developed from the phellogen, found on the outside of this layer, which is named phellem, and that formed on the inside of this layer, named phelloderm. According to von Höhnel, the phellem consists, or may consist, of two kinds of tissues—true cork cells, whose walls are suberized, and ligneous cells, whose walls are mainly wood. These latter are called phelloid, the former cork, and this without reference to the form of the cells, the substance of the cell wall being the ground of distinction. According to the plan of origin of the phellogen cells, there are two kinds of periderm, called superficial and deep-seated, sometimes, also, primary and secondary, as the superficial, when present, always precedes the deep-seated in order of time. De Bary makes this division, describes the superficial periderm and then says, "the position of the internal is not determinate in a sense generally applicable to all cases," and that this is owing to the number of transition forms between it and the superficial. He does not give the exact position of the phellogen layer of the internal periderm. Joseph Moeller,[10] in his Anatomie der Baumrinde, gives four classes of superficial periderm, considered with reference to the exact position of the phellogen layer. These, he says, may be reduced to three, when genetically considered. Of these three, the first is when the phellogen layer is the epidermis; the second, when it is situated in the primary rind; the third, when in the phloem of the vascular bundles. This last, he says, may be considered a transition form between the superficial and the deep-seated. For the latter, it must be inferred its place is in the phloem of the secondary growth,

[9] Comparative Anat. of Phanerogams and Ferns (Eng. trans.), pp. 114 and 544.

[10] Anatomie der Baumrinden. Vergleichende Studien von Dr. Joseph Moeller. Berlin, 1882.

or the phloem produced by the cambium ring after it is completed around the stem.

Difficult as it is to harmonize the different ways of describing the processes of periderm formation, as given by various writers, nearly all agree in the main features of that by which bark is produced, viz: bark is the product of the internal or deep-seated periderm, and it consists of all that portion of rind-tissue outside of this periderm, which tissue, cut off from nourishment by the corky layers of periderm, dies and is eventually thrown off. This is the *Borke* of the Germans and the *ecorce crevassée* of the French.[11] One form of internal periderm originates from phellogen cells extending in a nearly continuous layer around the stem; this gives rise to the so-called ring-bark, examples of which are Vitis and Clematis. Another form of internal periderm arises deeper in the rind of certain stems on which there is already a superficial periderm. The phellogen cells of this form, instead of extending in one layer around the whole circumference, arise in such a manner that, as De Bary expresses it, "they abut on the outermost layer of periderm for the time being," referring here to the repeated formation of internal periderm; the cork thus formed cuts off bark in the form of scales. The favorite example of this is the Platanus. Hence the two kinds, ring- and scale-bark. Now, accepting the definition of bark given by De Bary[12], we must exclude all those trees from the list of bark-bearing ones which do not have, at some period, one of the two forms of internal periderm. He quotes this definition, however, from von Mohl, and does not himself adhere strictly to it, as on a page or two previous he gives an instance of phellogen arising in the second or third subepidermal layer and cutting off a *small bark*. This, according to both De Bary and Moeller, must be considered as a superficial periderm, and the latter adheres more consistently to the definition of bark, inasmuch as he gives only 83 genera of bark-producing trees among the 392 specimens which he examined, and he expressly states that these 83 kinds possessed internal or secondary periderms.

Now, according to De Bary's explanation of superficial periderm, which differs from Moeller's only in its lack of definiteness, it is with this kind of periderm alone that our subject has to do. In connection with this, is one point sel-

[11] Traite de Botanique par J. Sachs. Traduit de l'allemand sur la 3d edition et annote par Ph. von Tieghem. 1874.

[12] Comp. Anat. p. 551.

dom noticed in text-books, and that is, that the superficial periderm also gives rise to two kinds of coverings, which De Bary names suberous crusts and suberous integuments (kork-krusten und kork häute). These two forms owe their origin to the difference in the manner of development of the cork or corky layers. Here De Bary classifies, apparently without reference to form of cell or nature of wall, meaning by cork the phellem, or all outside the phellogen layer. Where this develops with nearly equal rapidity around the whole circumference, it forms the suberous integument; where, owing to some cause, the development is irregular, certain portions of the phellogen producing faster than others, suberous crusts are formed, and it is in this category that he puts the cork-winged trees, together with all those having deep, irregular furrows and ridges along their surface.

It is in reference to certain differences in various cork-winged growths that the following study has been made, the author believing herself to have noticed some facts which may have a bearing on certain physiological questions at present under consideration. Although the number of species examined was quite limited, yet, for the sake of convenience, they may be considered as represented by three types, *Quercus macrocarpa* Michx., *Liquidambar styraciflua* L., and *Euonymus alata*. The latter genus is extremely interesting from a systematic standpoint. No two species examined agreed in the manner of cork development, while a variety differed from its species only by a slight and unimportant variation. Quercus macrocarpa, and those agreeing with it in structure, deviate less than the others from the so-called rough-barked trees, or those whose trunks are ridged and furrowed while their branches are smooth. The younger branches of Q. macrocarpa, however, are completely covered with a set of wings, generally five in number. The manner of their origin is as follows:

Anatomy of the superficial periderm of Q. macrocarpa.

Stems were examined July 10, which were taken from a tree a few days before from the Arnold arboretum, and which had been kept in a fresh, growing condition. At this time the young stem was covered with a periderm of six or seven layers; even the youngest internodes on the shortest branches, some not exceeding two millimeters in length,

were covered with a periderm of six or seven layers in thickness. Lenticels were very numerous over the whole internode. The wings do not originate until the internodes have reached about their full length. Their manner of origin may be said to follow a fixed law, though very many irregularities occur.

The stem, when young, is conspicuously five-angled, owing to the strongly developed leaf-traces. The periderm takes its rise from the subepidermal layer, developing uniformly around the stem till about five or six layers of cork have been formed. The epidermal cells, at first, appear to yield to this strain by stretching in the direction of the circumference until their tangential much exceeds their radial diameter. The large number of lenticels which develop at the same time with the periderm appears to diminish this strain somewhat, but as the growth of the periderm continues and the epidermal cells reach their full tension, they break at various points over the surface. At the projecting angles, where the strain is greatest, this giving way of the epidermal cells soon becomes insufficient to allow the necessary expansion, and the young, fresh periderm breaks in lines along these angles. A cross section at this stage shows from five to seven layers of periderm cells, which are living and active, as shown by the action of sugar solution when applied to them, plasmolysis at once taking place. Glycerine was tried, but produced no effect. It is quite probable it was not sufficiently dilute, as the solution was made at random in both cases. There can be no question about the result when the sugar solution was applied, and in several instances the cell nucleus was clearly seen. The tearing of these cells along the angles extends inward nearly to the phellogen layer, and, as a result, an abnormal vitality seems to be imparted to the phellogen cells immediately under the fissure. For a time this increased vitality of the phellogen layer does not extend entirely around the circumference, but only for a short distance each way from the fissure. This will be better understood by referring to the figures,* of which the first six represent this process of wing-development diagrammatically. In figure 1 the tearing of the tissue along the lines of the five angles is represented as lying at the points *a*. *a*. The bands of tissue represented as lying between the angles *o*. *o*. are composed of the original periderm of six or seven

*The plates will be published with the remainder of the text in the succeeding numbers.—EDS.

layers which first encircled the stem. In figure 2 the new growth of cells shown at *x. x.* is the product of the increased vitality of the phellogen cells near the fissure. This rapidity of growth and ability to form new cells by forming cross-walls in various directions is not confined to the phellogen layer of this vicinity, but extends also, for a limited time, to the cells produced by this layer. This is shown in figure 7 at *m*. This figure gives the actual appearance of a cross-section of stem, as represented by figure 2. Here it is evident that some of the cells, resulting from the division of phellogen cells, are themselves in the process of division. As represented in figure 2, this development of new cells extends only to the points *b. b.*, and is most rapid immediately under the line of the fissure. As growth continues for some time in about this ratio, the result is, the five sections of original periderm, *o. o.*, are not only pushed out, but the ends of each are curled toward each other, thus making a hollow furrow along the internode. This condition in its formative stages is represented in figures 4, 5 and 6, sections *o. o.*, the figures being made smaller merely for convenience as the real size of the wings increases. On testing these specimens with reagents, it was found that the cell walls of the sections *o. o.* consisted principally of suberin, while those formed later, represented by sections *x. x.*, are not true cork cells, but ligneous, and correspond to the phelloid of Höhnel. Figure 8 shows the actual appearance of these cork and phelloid cells, as represented in figure 4. Figure 9 shows merely the tip of the wing of figure 6.

This matter of difference in the chemical nature of the cell walls will be referred to again in connection with the physiology of the wings, where its consideration more properly belongs.

Returning now to the stage of growth represented in figures 2 and 3, it will be plain there are five longitudinal bands of rapidly growing tissue extending along the internode across each angle, while there are also bands between these, in which growth is for the time suspended. At what time the phellogen cells of these bands begin their activity again it is impossible to say. Sections cut from a two years old stem, of which figure 8 is an exact representation, so far as the outline of the different tissues is concerned, show that in this case growth of the phellogen cells of these five bands was suspended till toward the close of the summer's growth; then activity commenced all around the circumfer-

ence of the stem, and the narrow plate cells, *y*, were formed, extending entirely around the stem. In most cases, however, it is probable that growth of the entire phellogen layer is resumed earlier in the season than in the case of the section from which figure 8 was taken, and that, for some time, the same kind of tissue is produced as that forming the first five bands, viz: phelloid tissue, referred to on the figures by *x*. After some time the fall growth occurs and the ring of plate cells, *y*, is formed. This must have been the case in figure 9, which is also an exact representation of a section from another stem. Nearly all completed wings examined agree with figure 9 in this respect. It happened that the specimen from which figure 8 was drawn was the only one found which illustrates this stage of growth, that is, the gradual throwing outward the ends of the sections *o*, *o*, which process forms the furrow. This is, therefore, given to prove the manner of growth in this respect, while it is probable that figure 9 shows the most common form in respect to the time when the whole phellogen layer resumes its activity. However this may be, it never fails that in the autumn, just before growth of the entire tree is suspended, several layers of narrow plate cells are formed, whose chemical nature is the same as that of the first periderm sections *o*, *o*. The fissure, at this time, extends in some cases entirely down to this mantle of thicker walled cells; in the specimen sketched, figure 8, still several layers are left intact between the ring of plate-cells and the outside air. In this condition the winter is passed. In the spring the entire phellogen layer resumes its activity, rapidly developing phelloid cells with thin walls and long radial diameter. This continues till the strain is too great to be borne by the walls of the surrounding plate-cells, and they break regularly along the lines of the preceding years' fissures, *a*, *a*. Growth continues during the summer nearly uniformly as the foundations for the wings are laid, and the breaking of the new tissue follows the lines already begun. At the close of the second season the same process occurs as in the preceding fall, viz.: several layers of narrow plate-cells are formed around the entire circumference. In this way large cork wings are formed, enlarging each year at the base as the stem increases in thickness. It is seldom that they are perfectly regular in their whole length, but on nearly all the older branches the number five may be recognized, and the little hollow furrow running along the top of each wing may be plainly seen. Fig. 10 shows a

cross-section of a stem four years old, in which only two of the wings show the furrow, owing to the fact that at the point where this section was cut, the furrows of the remaining three wings were not perfectly developed. As the phelloderm plays no important part in the formation of cork from the standpoint of our subject, no attention was given to this throughout the study made.

Philadelphia, Penn.

Characteristic vegetation of the North American desert.

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The term desert has a somewhat wide application. In one sense it is applied to a tract of country practically destitute of vegetation from sterility of soil. Such sterility, however, is not always the fault of the soil, but is due to the absence of water in sufficient quantity to promote vegetation. Our ideas of a desert are largely drawn from popular descriptions of some portions of the Great Sahara, where low plains covered with drifting sand, interspersed with vast fields of naked rock, spread over regions over which the traveler might pass for days without meeting with a drop of water or a blade of grass. Such cases are met with, but then occasionally an oasis is met an island of verdure, where, around cool springs of water, flourishes a tropical vegetation of palms, ferns and acacias. But this description covers only a part of what is known as the Sahara Desert.

Explorations of travelers and scientists show that the great desert is a region of elevated plains rising up into mountains of 300 to 500 feet in height, and separated from each other by valleys, immense sandy tracts at a general elevation of from 1,200 to 1,500 feet, but sinking at times into depressions which sometimes descend below the level of the sea.

The moisture from the Mediterranean Sea is arrested in its southward passage by the range of mountains running nearly parallel with it, and is mainly precipitated on the north or Mediterranean side; thus the southern slopes are left in an arid condition, the aridity increasing as the country recedes from the mountain ranges and peaks, where snow falls in the winter, and, melting in the summer, runs down the narrow courses and ravines until it is finally wasted in

the sands of the desert. Similar causes, as is well known, operate in our own country for the production of our arid districts, particularly in what is called the Great Basin. A few years ago it was the custom to speak of the country now embraced in the states of Kansas, Nebraska and New Mexico as the Great American Desert.

A large portion of this country, although blessed with but a limited rain-fall, proves to be capable of remunerative cultivation.

There are some stretches of loose, sandy soil supporting only a sparse vegetati n of Chenopodiaceous shrubs and coarse grasses, but these are of limited extent.

It is to the strip of country lying at the eastern base of the Sierra Nevada range of mountains, and at the south where this range breaks down into high and extensive plateaus in Arizona and southeastern California, that we find our nearest approach to a true desert, and to this region our remarks will, for the most part, be confined. For a general description of the physical features of this region I shall avail myself of many of the observations of Mr. Sereno Watson, as given in his report of the botany of the 40th parallel.

In the northern part of this district the basin extends from the base of the Sierras eastward to the Wahsatch Mountains, a distance of over 400 miles. This span is occupied mainly by numerous short and isolated and minor ranges, having a general north and south trend, and at an average distance of about twenty miles. The bases of these ranges are usually very narrow, even in the most elevated rarely exceeding eight or ten miles in breadth, the slopes abrupt and the lines of foot-hills contracted, the mesas grading at a low and uniform angle into the broad interrupted valleys. Over the larger portion of the territory, especially in Nevada, the combined areas of the valleys and the areas occupied by the mountains are very nearly equal. The greater portion of the basin at this point is drained by the Humboldt River, which traverses the territory from northeast to southwest, and terminates in Humboldt Lake, which has no outlet. The other smaller streams of the region likewise lose themselves at other points in the main depression of the basin at an altitude of about 3,800 feet above the sea. The mountain ranges of the basin vary in altitude from 1,000 to 6,000 feet above the valleys.

"They are cut up by numerous ravines or cañons, which

are narrow, very rarely with an acre of interval or surface approaching to a level, the sides sometimes rocky or precipitous, more frequently sloping to the summits of the lateral ridges. With few exceptions, also, these mountains are for most of the year destitute of water, with but small rivulets in the principal cañons, frequently with only scant streams here and there at their bases, irrigating a few square yards of ground. Even where the mountain supply is sufficient to send a stream into the valleys, it is usually either soon entirely evaporated, sinks into the porous soil, or becomes demoralized with alkali and is lost in the mud of the plain."

The amount of rain-fall in this region is not definitely known. "It varies greatly with the altitude, and is probably considerably more upon the eastern slope of the mountains than upon the western. Though any statement of the average annual amount must be largely conjectural, yet it may be roughly estimated at eighteen inches, of which one-half may be considered as falling between April and November, inclusive." "No portion of this district, however desert in repute and in fact, is destitute of some amount of vegetation, even in the driest seasons, excepting only the alkali flats, which are usually of quite limited extent. Even these have frequently a scattered growth of Sarcobatus or Halostachys surmounting isolated hillocks of drifted sand compacted by their roots and buried branches." With these in alkaline soils are usually combined several other Chenopodiaceous plants, such as Salicornia herbacea, several species of Suæda, Kochia prostrata, Eurotia lanata, Grayia polygaloides, Schoberia occidentalis, and several species of Atriplex. In addition, there are two species of Thelypodium, three of Cleomella, one of Astragalus, two species of Aplopappus, one Crepis, one Cressa, Lycium Andersoni, Erythræa Nuttallii, and of grasses chiefly Distichlis maritima, Spartina gracilis and Sporobolus asperifolius. There is an almost universal absence of trees. In the valleys of the Humboldt, Truckee and Carson Rivers, Populus monilifera and P. trichocarpa are found sometimes in considerable numbers. Several shrubs besides those mentioned above, sometimes mingled with those in alkaline soils, as the "everlasting sage-brush," Artemisia tridentata, and the similar, but smaller, Artemisia trifida. These are often accompanied by Bigelovia graveolens, called broom-sage, and Tetradymia canescens, and along the fresh water streams two species of shrubby willows. On the foot-hills only is found the shrubby

Purshia tridentata. "The mountains are, in a large measure, as destitute of trees as the valleys, or even more naked, from the dwarfed character of the shrubs upon the exposed ridges and summits."

On the higher ranges a sparse supply of Pinus monophylla, the nut pine, with two or three species of Juniperus, or red cedars, is to be found. The mountain mahogany, Cercocarpus ledifolis, is of frequent occurrence on high ranges at an altitude of 6,000 or 8,000 feet.

Mr. Watson gives a list of the peculiarly desert species of the northern portion of the basin, amounting to 305, of which about one-third are strictly confined to the basin, quite a large number of which are southern and have extended up from the desert portions of Arizona and southeastern California. Going southward, the desert district by the trend of the Sierras is deflected eastward, and in the southern part of Nevada the Rio Virgin and its branches are reached, where the drainage of the country is to the Colorado River. A little further south, the Mohave River, coming in from the west, traverses the desert region of southeastern California. Crossing the Colorado into Arizona, we find that entire state and the western portion of New Mexico drained by the Little Colorado and the Gila Rivers, having their origin and affluents in various mountain ranges, some of which rise to 10,000 to 11,500 feet altitude, furnishing above 6,000 feet exclusive forests of pine, spruce and cedar. At elevations of 6,000 feet several species of oak and other deciduous trees are sparsely spread over the mountain declivities. The country then descends into broken plains, or in some places, particularly in the northern portions bordering the Colorado, into extensive plateaus. Over a large portion of the state these plains afford a scanty supply of grasses and small shrubs which give support to thousands of cattle, but often they become dreary stretches of barren, sandy soil entirely destitute of water for distances of from twenty to fifty miles. The vegetation of these plains and mountain slopes becomes very peculiar and striking. I will quote a few paragraphs from Dr. J. T. Rothrock in his description of this remarkable region. He says: "Crossing a series of mesa lands at an elevation of 6,000 to 7,000 feet, we begin the descent to the parched, superheated valley of the Gila River. A complete change comes over the flora. If verdure and superabundant vitality were the expression of the plant life on the timber-clad Mogollon mesa, in the valley of the Gila, hardness of texture

and contraction of form would be characteristic of the flora. The attempt to make an analysis of one's feelings on being somewhat unexpectedly brought face to face with this peculiar vegetation would be futile, as no point of comparison appears to offer. The giant Cereus occupies the hill-sides which have a southern and southeastern exposure, towering up to a height of from thirty to fifty feet. Fouquieria, with the leafless, wand-like trunk, and its tips of scarlet flowers; Agave Palmeri and Agave Parryi, and various species of Dasylirion, dry, rigid skeletons of plants without the living green; Canotia, a tree twenty feet high, a foot in diameter, with green branches provided with stomata, but no leaves, all go to complete this desolate floral landscape, white with Mimosa. Acaciæ and Calliandræ, rising to the dignity of trees or dwarfed to mere underbrush, inhabit the dry hill-sides and ravines, but still by their small leaves and hardened tissues show that they, too, have the impress of the dry, hot air about them." One of the most conspicuous of the desert shrubs is Larrea Mexicana, commonly called creosote-bush, which has a strong aromatic fragrance, plainly perceptible in the air, and exuding a reddish-brown resinous matter on the branches. It is reputed to have strong medicinal virtues. Several kinds of Rhamnaceous shrubs also are frequently met with, among them species of Zizyphus and Karwinskia. The order Leguminosæ has a pretty abundant representation in peculiar species in the desert region, particularly the genera Astragalus, Galea, Cassia, Acacia and Mimosa.

The mesquit tree, Prosopis juliflora, extends through the dry regions from Texas to southern California, sometimes becoming a tree of from thirty to forty feet high, and forming dense thickets, more commonly a mere bush, bearing freely bean-like pods, which are valuable forage for mules and horses while making hard marches. The wood is frequently the main dependence for fuel. Several thorny shrubs of the genus Parkinsonia, with smooth, light-green bark, and small, scant leaves, but conspicuous contracted pods, form a common feature of the landscape. But the most abundant and characteristic plants of the desert region are the many genera and species of Cactaceæ, varying from the giant Cereus to the various forms of flat-branched and cylindrical Opuntias, intermixed with Mamillarias and Echinocacti in great number. Cereus giganteus, or the tree cactus, attains a height of from twenty to fifty feet, and is probably half a

century in attaining its maximum size. It is sometimes entirely unbranched, but often with a few, two or three, or even up to nine branches, which, almost immediately after leaving the trunk, turn upward and grow parallel with the main stem, presenting sometimes the appearance of an immense candelabrum. The trunk of the older trees is often two feet in diameter. It begins to flower when ten to twelve feet high. The flowers are borne near the summit of the stem and branches, and are succeeded by a roundish or pear-shaped fleshy fruit two to three inches long by one and one-half to two inches thick. The interior of this fruit is of a crimson color when ripe, of the consistency of a fig, and of a sweet, but rather insipid taste. They are eaten by the Indians of the country, who reach and detach them by means of a long pointed reed. Cereus Thurberi is a smaller species, found in southern Arizona and thence into Mexico. It grows in clusters of five to ten stems from one root, and rises to the height of ten or fifteen feet. The fruit is said to be delicious. Many genera of Compositæ have a great development in the desert region. In the sandy arroyos there occur several species of Baccharis, together with the well-known Indian arrow-wood, Pluchea borealis. Other genera are Brickellia, Aplopappus, Bigelovia, Verbesina, Riddellia, Pectis, Tagetes, Artemisia, Perezia, Lygodesmia, etc. Many species, also, of Convolvulaceæ, Solanaceæ and Scophulariaceæ are conspicuous. A Bignoniaceous shrub (Chilopsis saligna), with handsome corymbs of flowers, sometimes enlivens the dreary stretches of land, especially in the vicinity of water, and, on account of its narrow, willow-like leaves, is known as the desert willow. The orders Amarantaceæ, Chenopodiaceæ and Euphorbiaceæ are represented by many species. Next the Cactaceæ, the most striking features of the vegetation are the various species of Agave and Yucca. Yucca baccata usually has a short stem, but in the southwest it sometimes develops a trunk eight or ten feet high covered with refracted dead leaves, and bearing at the apex a large panicle of lily-like white flowers, which are succeeded by an indehiscent, fleshy pod; these are eaten by both whites and Indians, and cured by the Indians for winter food. They also stew the flower buds and flowers, which are said to be nutritious. Yucca brevifolia makes a tree from fifteen to thirty feet high, with rough barked trunk one to two feet thick, dividing into a number of branches, each of which is terminated by a close tuft of thick, stiff leaves six to ten inches

long, and below covered with older dead and reflexed leaves. This species was some years ago largely collected and manufactured into paper and paper pulp. It forms, in some places, quite extensive scattered forests, which have a very peculiar appearance. The narrow-leaved Yucca (Y. elata) occurs on dry hills and ridges, has a trunk three to ten feet high, with extremely narrow leaves one foot to eighteen inches long, and throws up a narrow panicle as long as the trunk. It is one of the most stately of Yuccas. Yucca Whipplei is abundant in Southern California, extending eastward into Arizona. It has a short trunk, with leaves ten to twenty inches long, and sends up a lower scape to the height of from four to twelve feet, bearing a densely flowered, narrow panicle of greenish-white flowers, which are succeeded by capsules one to two inches long. The leaves furnish a coarse fiber which is used for stuffing saddles and similar purposes.

In the desert region several species of the genus Agave are conspicuous, among which are Agave Schottii, Agave Utahensis, Agave Newberryi, Agave deserti, Agave Parryi, Agave Palmeri, and, in the southwest corner of California, Agave Shawii. The Agaves are chiefly stemless plants with a mass of large, stiff and pulpy leaves crowded together at the surface of the ground, which leaves are generally armed on the margins with coarse, spiny-tipped teeth. There is said to be over 120 species of this genus in Mexico, one of which, called the maguey plant, is of immense importance in furnishing that universal Mexican beverage called pulque. In the vicinity of Mexican cities immense plantations are given up to the cultivation of the plant. At the proper time the crown of the plant is cut out and an excavation made, in which a stream of juice continually flows, and is collected daily by a man who is called a pulquello, going through the fields with a leathern sack on his back into which he pours the pulque fluid, which he takes from the excavations with a dipper. This fluid, after fermentation, forms the beverage above named, which is in universal use among the Mexicans.

A striking feature of some of the dry, sheltered cañons of western Arizona and southern California is the American palm, Washingtonia filifera. It attains a height of thirty or forty feet, with a cylindrical trunk two to three feet in diameter, crowned at the top with rather a close tuft of much divided leaves, whose margins are ornamented with loose,

hanging threads. This palm is now cultivated for ornament in many places in California, and has also been introduced into green-house culture in Europe. An attempt has been made at one place in southern California to utilize a portion of the rough barrens country for an ostrich farm. Ostriches have been introduced from Africa, and are kept in large inclosed tracts, where they have abundant freedom. The climate seems to be quite agreeable to them, and their culture promises success.

Washington, D. C.

The stem of Ephedra.[1]

WALTER H. EVANS.

(WITH PLATE XXI.)

According to Bentham and Hooker, Ephedra occupies an intermediate position between Welwitschia and Gnetum in the order Gnetaceæ. Holding thus a low rank among Gymnosperms, we would expect interesting anatomical structures. In all there are about thirty species, most of which are tropical. Within the United States five or six species have been found, and their range is from Ft. Bridger, Wyoming territory, Colorado and Texas, through Utah, Nevada and Arizona to California.

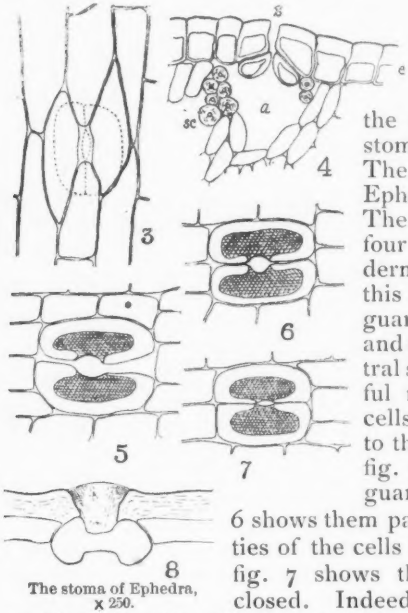
In this study I used the *Ephedra Nevadensis* Wats. and compared with it *E. aspersa* Engelm., *E. pedunculata* Engelm., *E. vulgaris* Rich., *E. trifurca* Torr., and *E. monostachya* L., all of which seemed to differ in no important detail from the type used.

To the casual observer the stem of Ephedra seems to be a jointed affair, branching variously and attaining a height of from six inches to as many feet. He is struck with the close resemblance which the young branches bear to the common horse-tail rush. The stem bears no leaves, but at the nodes of the young shoots are two or three scale-like bracts one to six lines long and usually of a brownish color. In the cases observed, all these scales were deciduous after the first year's growth, while in some cases they were not retained throughout the growing season. These scales are, in all probability, rudimentary leaves, yet they do no leaf work, have no fibro-vascular connection with the stem, and

[1] Contribution from the botanical laboratory of Wabash College.

seem to be but developments of the cortex and epidermis. In the axils of these bracts occur whatever flowers or branches the plant bears.

The epidermis of the stem is rather rough, and is composed of irregularly shaped cells. The outer wall is often considerably cuticularized, frequently becoming half the thickness of the cell. Numerous processes, like very rudimentary trichomes, cover the epidermis, and in optical section give it the appearance of being covered with small knobs. The cortex (fig. 1, *c*.), is for the most part made up of palisade parenchyma, containing chlorophyll. This chlorophyll-bearing parenchyma completely invests the young shoots except at the nodes, where it is abruptly terminated. Within this part of the plant all the leaf work is done. As the stem increases in age the epidermis becomes more cuticularized, the wood tissues encroach more and more upon the cortex, and when from three to five years old its leaf work is over and the stem has lost all resemblance to the rush.



The stoma of Ephedra, x 250.

Arranged either in single or double vertical rows in the epidermis, and leading into the cortex, are found the stomata (fig. 2, *s*, *s*, *s*, etc.). The stomatic structure of Ephedra is a curious one. The opening is formed by four specially developed epidermal cells (fig. 3). Below this opening are placed the guard cells, two in number, and ovate triangular in a central section (fig. 4). By careful manipulation the guard cells may be seen to respond to the presence of water. In fig. 5 is shown a stoma with guard cells wide apart. Fig. 6 shows them partly closed, the extremities of the cells being in contact; while fig. 7 shows them still more nearly closed. Indeed it is only after a long soaking that the slit opening can be entirely closed. Of

course, this process is presumably the reverse of that which would take place were the guard cells in their normal position in relation to the surrounding tissues. In fig. 8 a longitudinal radial section of the stoma is given. Below the stoma the usual air-chamber is found.

Scattered singly or in groups of from two to ten within the cortex, and also the pith, are found very long sclerenchymatous fibers. They are thick-walled and shining. Their length is indefinite, but seems usually to equal that of the internodes. These fibers are much more numerous in the cortex than in the pith. Next within the cortex is found the bundle sheath of very delicate walled cells. Within this is the phloem, containing the sieve vessels and the accompanying cells of soft bast. Next comes the xylem area, resembling that of Pinus very much, having rectangular-shaped cells with heavy lignified walls. The medullary rays are not very prominent even in the most favorable circumstances. Within the xylem area, and forming the central part of the stem, is the pith, of rather large irregular cells.

In my study I used, with good results, chlor-iodide of zinc as a staining fluid. The xylem and the pith take on but little stain, and are seen as yellowish brown. The phloem takes on a very pretty blue, the cortex a darker color, and the sclerenchymatous fibers a beautiful pink. If the sections stand too long in the reagent, the phloem and the parenchyma adjoining it take up so much color that they can not be readily distinguished. No trouble can be met with in distinguishing the characteristic cells of the xylem and the pith.

In longitudinal radial section we get a very similar arrangement of parts as in transverse section. The epidermis, cortex, sclerenchymatous fibers and bundle sheath, except as mentioned already, differ in no respect from the forms usually characterizing such tissues. The phloem is composed of cells of considerable length. They are rather thin-walled and have blunt ends. In the xylem area there are striking differences. Some of the cells are quite long as compared with surrounding ones. These long cells are generally horizontally or spirally banded, and the walls are rather thick (fig. 10, *sp.*). Other cells are shorter, and have the usual tapering ends of all tracheids. Most of these are more or less spirally banded, and have thinner walls. Some in the older wood have the characteristic disk markings of all gymnospermous stems, while others have both the disks and spiral markings. The pith cells are different in no respect from

those found in such stems. However, it often contains a sort of reddish brown coloring matter, a secretion which is soluble in water at ordinary temperatures, showing it can not be "a kind of resin," as has been claimed.

Just above each node, except in E. monostachya, is found a most curious structure. Running across the stem is a sort of diaphragm of three or four cells thickness. This completely cuts off the pith and often the xylem also (fig. 11). Whenever any of the tracheids pierce this they are the long, heavy-walled ones spoken of above. After acting as an almost complete partition in the region mentioned, it seems to merge into the phloem on either side. The cells making up this curious structure are rather thin-walled, and about three times as long as broad. When treated with chloriodide of zinc they take the characteristic color of the phloem. Just what the office of these cells can be, I am not prepared to say. They may be active meristem cells, and the growth of the internode may be found in this layer. I found that wherever this exists it forms a line of easy division, and the brittle stems always break at this point. If the other habits of the plant would warrant it, this may be a means for propagation, since by breaking as it does there can be no injury to the node, and if the plant will grow from cuttings this may be nature's way of providing them.

Crawfordsville, Ind.

EXPLANATION OF PLATE XXI AND FIGURES IN TEXT.—Fig. 1. Cross section of stem: *e*, epidermis; *c*, cortex; *b*, bundle sheath; *ph*, phloem; *xy*, xylem; *p*, pith; *sc*, sclerenchymatous fibers; *s*, *s*, *s*, stomata; *a*, *a*, *a*, air chambers.

Fig. 2. Surface section of epidermis, showing vertical rows of stomata.

Fig. 3. Epidermal cells surrounding a stoma.

Fig. 4. Cross section of stoma: *s*, stoma, guard cells below; *a*, air chamber; *e*, epidermis; *sc*, sclerenchymatous fibers.

Fig. 5. Guard cells dry.

Fig. 6. Same, partly closed.

Fig. 7. Same, nearly swelled shut.

Fig. 8. Longitudinal section of stoma.

Fig. 9. Longitudinal section of stem, lettered as in fig. 1.

Fig. 10. Elements in longitudinal view: *sc*, sclerenchymatous fiber; *sp*, long tracheid; *tr*, forms of tracheids; *p*, pith.

Fig. 11. Showing diaphragm above node as in longitudinal section.

Fig. 12. More highly magnified portion of same.

Figures 3—8, × 250; 1, 2, 9, 10, 12, × 125; 11, × 24.

A tramp in the North Carolina mountains. I.

L. N. JOHNSON.

One of the wildest regions east of the Rockies, and at the same time one of the most interesting to a botanist, is the mountain region of western North Carolina. The combination of low latitude and great altitude produces, as might be expected, a varied flora.

It was the good fortune of the writer to be one of a party who tramped through these mountains during the past summer on a botanizing trip. Our route was two hundred miles long, extending through Jackson, Macon and Swain counties. We had laid it out in such a way as to cover both mountain peak and valley.

One might fill pages with descriptions of the beauties of the scenery, but we must here confine ourselves to the flora, and that briefly. Although our trip was made just too late for the spring flowers and before those of summer were fully developed, we identified about five hundred and fifty species without any attempt at an exhaustive study.

Of course the Compositæ headed the list in number of species, but to us the most striking feature was the great abundance of the Leguminosæ, both in species and individuals. The soil is a red clay and seems to be peculiarly adapted to them. We found thirty-five species in blossom. Along the roadsides, especially in the valleys, were great quantities of the showy flowers of the Butterfly peas, Clitoria Mariana and Centrosema Virginiana. Scarcely less abundant, but perhaps more local, was the Schrankia uncinata. The Cherokees call this the "Bashful brier," in allusion to the sensitive character of the leaves. Of course, the common clovers are seen, though the white clover is not so abundant as in the north. The turf by the roadside in many places is made up by the stalks of a small leguminose plant with trifoliate leaves, somewhat resembling clover. It was not in blossom at the time we saw it.

Desmodiums are very abundant and of many species. One of the most variable of the Leguminosæ that we found is the Stylosanthes elatior. Its yellow blossoms were everywhere, but its stalks were sometimes erect, at others almost trailing, while the leaves vary in form and size. A very showy member of the family is the Thermopsis Caroliniana.

Its tall, simple stalk and long raceme of yellow flowers catch the eye here and there on the mountain side, though it is not abundant.

Among the other interesting Leguminosæ which one may hope to find are Rhynchosia tomentosa, var. erecta, Phaseolus perennis and P. helvolus, Tephrosia spicata, and a dozen others.

In striking contrast with the abundance of Leguminosæ is the almost total lack of Cruciferæ. We found only four species in all the mountains.

Of the Compositæ, the most conspicuous members in July are the Cacalias and the Silphiums. C. atriplicifolia and C. reniformis represent the former genus, while there are three species of Silphium found in abundance. Of course Asters are plenty, though our trip was a little too early for them. At Tuckaseege Falls we found Cynthia Dandelion and its variety montana growing abundantly on rocks continually wet by the spray. Elephantopus tomentosus was another species new to us.

The Rubiaceæ are everywhere well represented by Diodia teres, several species of Houstonia, which are among the commonest weeds, and by a number of Galiums.

The list of common flowers might be almost indefinitely extended. Probably none would sooner attract the attention of a stranger than the "wild potato vine," Ipomœa pandurata, growing with the beautiful passion flower (Passiflora incarnata), and its smaller relative, P. lutea, everywhere in the cornfields.

We have spoken thus far of some of the common flowers one may hope to meet with in a tramp through the mountains in the latter part of June or in July, purposely omitting the Ericaceæ till some future time. Now let us turn to the question of habitat.

We climbed Whiteside and Wayah Bald, two of the highest peaks in that section of the state, naturally hoping to find many new plants. In each case we were somewhat disappointed. On Whiteside, though the species were numerous, we found very few things not afterward seen in the valleys, the only ones being the little heath, Leiophyllum buxifolium and the rock fern, Asplenium Ruta-muraria. On Wayah Bald we found Pogonia pendula and an abundance of Potentilla tridentata. On the slopes grew the Chamælirium luteum, which is usually considered a lowland plant. Though we found so few new plants on these high summits, we were

greatly surprised at some of the things we did find. On the very crest of Whiteside, in the dry soil, were no less than four species of Orchids, all of them found in the swamps of the lowest parts of the state visited. This was not an unusual case, for it became an object of common remark among us that distinctions of habitat fail here. Most of the plants seem to be found indifferently on the mountain tops and in the valleys, on dry slopes or in the swamps.

The effect of altitude on the time of blossoming of some of our common plants was clearly seen. We often found the Hypoxys erecta in blossom, and on Whiteside we found Aquilegia Canadensis in bloom on the 12th of July, and on the Nantehala mountains a week later the Tiarella cordifolia, both early spring flowers. It was unexpected to find these flowers in their prime so late in the season at a point so far south.

Evanston, Ill.

BRIEFER ARTICLES.

New variety of Asclepias tuberosa.—Asclepias tuberosa is one of the well marked species of the genus, with its hairy stem (destitute of a milky juice), scattered leaves and orange-colored flowers. Only one variety, decumbens, is given in Gray's Synoptical Flora. A form different from this, and one which seems to be well entitled to a varietal name, has been in my herbarium for some years, and I now wish to characterize it as a new variety.

Asclepias tuberosa, var. *flexuosa*. Stem flexuous: leaves sub-opposite, a pair at each node: the flexuous stem is caused by a peculiar curvature of the internodes.—Cumberland mountains, Tennessee. *Miss M. Mohr.*—JOSEPH F. JAMES, *Oxford, Ohio.*

Exploding fruits.—While out collecting recently I gathered a considerable quantity of Euphorbia serpyllifolia in fruit. Upon arriving home the plants were taken from the press for examination, as a fungus was detected uponthe leaves. While attending to some other specimens I heard a strange little ticking sound which might be compared with the noise made by the little beetles often found in old furniture, known as "death-watch beetles." Upon examination, it was found that the ripe capsules were bursting open and scattering their seeds in all directions. The capsules are not two lines long, yet the explosive power of their elastic valves is so great as to throw the seeds fully three feet away. Many of these bursting capsules were watched, and the average distance seeds were thrown was about two feet, sometimes a little less and often a good deal more.—F. W. ANDERSON, *Great Falls, Mont.*

Drying botanical specimens in sand.—This mode of drying specimens can not be called new, but, so far as I know, it is little practiced. Sometimes a botanist needs a faithful drawing of a plant as a whole, or in part. Perhaps he is too busy to make it at once, and may not have time to do it until the season of the plant is past. An herbarium specimen is not a satisfactory object for his purpose, and yet sometimes he must make it do. In the average case of this kind, the unfortunate victim of circumstances will find a sand-dried specimen to be as good for his purpose as the living plant. Suppose one wants to make a drawing of *Œnothera caespitosa* Nutt., and can not find time for the work until the plant has been out of bloom a month. By faithfully following the directions offered he will have just what he needs: Take a tin can, or other vessel large enough to hold the specimen without cramping in the least degree. Place the specimen in the vessel in a natural position. Carefully sift into the vessel very fine, clean sand, previously warmed in an oven. Gently tap the outside of the can from time to time, in order to settle the sand slowly and evenly about the specimen. Sift in the sand until the specimen is completely covered. When this is done properly, every leaf is buried in its natural shape; even the delicate stamens and the more delicate petals are packed in the exact position in which they were developed. In removing the sand, after the specimen is dry, which takes from six hours to a week, according to its nature, great care must be exercised so as not to break the more fragile parts of the plant. To do the work nicely one should have a can made for the purpose. This need causes me to suggest the following device, which answers well. The size of this vessel will depend upon the individual requirements of the owner. It consists of a can with a funnel-shaped bottom, having the aperture closed with a screw-cap. It may be conveniently supported in a wooden frame. This is a simple contrivance and not expensive. If one so desires, a rubber tube may be attached to the outlet at the bottom, through which the sand may be run into some convenient receptacle and saved for future use.

Specimens dried by this method are not nearly so brittle as pressed ones; they retain their colors perfectly, as a usual thing, but they can not be recommended for the herbarium, because they take up too much valuable space.—F. W. Anderson, *Great Falls, Mont.*

EDITORIAL.

The discussion concerning botanical nomenclature is now fairly on and can do no harm. Mr. Britten, in the *Journal of Botany* (Sept.), has written at some length concerning "recent tendencies in American botanical nomenclature," taking for his text the recently published catalogue of New York plants, and, in the main, protesting against the proposed changes. Mr. E. E. Sterns, in the *Bulletin of the Torrey Club* (Sept.), puts very clearly the views of those advocating reform in nomenclature,

and seeks to unmask opinion by proposing articles of agreement for signature, a sort of marshalling of the opposing forces. This might work in war, but is hardly practicable in mere questions of opinion. It smacks too much of the "stand-by-your-guns" principle, and does not leave enough of a loop-hole for some of us to crawl through and change sides when we want to be "converted and absorbed." The agreement proposed for signature practically settles the question for those who sign it, and announces that it is no longer open for discussion so far as they are concerned. The same, of course, would be true of any opposing agreement. We consider this, therefore, hardly the practicable way to begin a friendly discussion, in which one party is expected to eventually absorb the other, but simply a way to insure their never agreeing. It is suggested that the opposition to this reform may come from inertia, jealousy, or an honest difference of opinion. The first two, it is said, are so unworthy as "to be passed in silence," with which statement we heartily agree, and would even add that they are so unworthy that they should not even have been mentioned. One thing that will make the discussion confusing and lack directness of contact is the attempt to discuss more than one question at a time. It is our opinion that we could take the question as to the priority of genera as settled, as there seems to be no ground for argument in the case. It only becomes a question of certainty as to what the authors had in mind, and then as to publication. As to the rights of the specific appellation and manner of citing authorities, there may be honest differences of opinion; but the former question is so much more important than the latter that it may well be the only one considered at present. Proper citation of a name can only be considered after the name itself is settled. The absolute necessity of making a specific name permanent is not open to argument; it is only a question as to the best plan. It should also not be questioned as to our own procedure when we transfer a species to another genus; of course we should use the same specific name unless we find it preoccupied. It is a very different thing, as we look at it, to make a third combination, which can be referred to neither of the previous authors; but even in this we might be induced to vote with the majority if it did not involve the digging up of long buried and forgotten names to the utter confusion of the present fairly established names of many plants, and these forgotten names too often very uncertain of application. It has been our thought, therefore, in view of the well nigh hopeless task of discovering the meaning of even the majority of oldest specific names, that the simplest practice was to take the oldest combination of generic and specific names. To sum up, therefore, the old botanist (for we take for granted that the recent ones would not do it) who transferred a species and changed its specific name should not have done it (if he knew of the existence of the former name); but, having done it, the name stands. We do not write this to express our readiness to sign an agreement in opposition to that referred to, for we still want to remain open to conviction.

OPEN LETTERS.

Peloria of Linaria vulgaris.

I had, to-day, the most extraordinary confirmation of the idea sometimes cherished, that when the mind is charged with a particular notion the subject is not far to seek. Passing near a lot covered over with Linaria vulgaris in full bloom I said, "Now is my chance for peloria!" Sure enough, though the incredulous may smile, at my very feet was a bed of twenty or more plants, all showing it, and in most fanciful ways. I have in other seasons occasionally met with a single flower so reverted at the top of a stem, but here were flowers with five spurs, some with three, some with two, and others normal, all on the same stems; this, too, shown by many distinct plants. All the peloric blossoms examined show an androecium of five stamens, irrespective of the number of spurs. There are, also, five lobes to the corolla in each case. Some of the flowers are disposed in whorls, these nearest the top of the stem, as if the raceme were breaking up. The number of spurs decreases in acropetal order. In one flower fasciation is shown as well as peloria; the result is a corolla of two *double* spurs, a corrugated palate, an upper lip of four lobes, and a lower of six lobes. It is especially to be noted, in view of the "supply of energy" theory, that these flowers are all along the stems, not necessarily at the top, and that the lowest of flowers, as a rule, are most peloric. Gray's Manual states that Dr. Darlington observed the peloric state of Linaria vulgaris in Pennsylvania. For real good Yankee eccentricity, Rhode Island is, as ever, ahead.

Providence, R. I. W. W. BAILEY.

Botanical papers at the A. A. A. S.

Referring to the biological section of the American Association, the GAZETTE remarks: "Very little can be claimed, however, for the quality of the botanical papers. With some exceptions, they showed a narrowness of observation and a superficiality of study which were lamentable." As the only papers these can possibly refer to, from the synopsis given in the GAZETTE (the others being commended, or only read by title or brief abstract) were Professor Sturtevant's, Professor Schrenk's, Professor Halsted's, Professor Beal's, or Mr. Meehan's, and as the editorial notes show which papers the "cap" is intended "to fit," I trust you will allow me to remark that I should feel no right to object to this decision of the editors of the GAZETTE if I felt that my papers were understood by those who listened to them. Indeed, I do not now object to your decision, but simply desire to ask the reader to compare the abstracts as given, with the notes of what the objectors said in proving the point that the essays must have been misunderstood.

I had no other object in presenting the papers than to contribute to the interest of the meeting, and I can only say, in regard to the quality of the entertainment offered, as Dr. Gray once said when told that a brother botanist had declared that he could "get out a better manual" than the doctor had done, "He is the man I want to see. By all means, let him bring his manual out." No one will be more pleased with better papers than I.

Having, however, the above thought of temporary interest only in view, I had no idea of publishing my papers in the form in which they were then presented; but in view of the sharp, and perhaps just, criti-

cism of the editors of the GAZETTE, it will only be fair to myself that I take the benefit of the doubt, and lay them in full before my fellow students, and I hope before long to find some opportunity of doing so.

Germantown, Pa. THOMAS MEEHAN.

[The GAZETTE's criticism was not directed wholly to Mr. Meehan's papers, as he assumes. Much less were any papers judged by the amount of "entertainment" or "temporary interest" they afforded. The criticism was aimed wholly at their character as *scientific* productions, as which, it is to be assumed, they are presented.—EDS.]

CURRENT LITERATURE.

Origin of our Trees.

Paleobotany, founded by Adolphe Brongniart, is a subject of great and increasing interest. The difficulties with which it has to contend are enormous, and its growth necessarily slow, but a few years has brought much information, and paleobotanists are to be commended for their great activity. Eminent among the multiplying workers is Count Saporta, whose last work[1] is before us, on the origin of trees cultivated or used by man. The text is interspersed with 44 excellent figures, and the whole treatment of the subject is remarkably clear. Of course it would be impossible in this brief sketch to give any detailed account of a book which is entirely made up of details, but a brief synopsis of contents will serve. The subject proper begins with a discussion of the various groups of gymnosperms; in the second division the monocotyledons are considered, with such forms as the palms and smilax; the third and largest division is devoted to dicotyledons, its many arborescent orders being taken up in succession. The figures are very suggestive, and being usually labelled as the ancestral forms of familiar modern groups, at once catch the attention of a botanist. One of the most excellent features of the book is a synoptical table, which gives in a condensed form, arranged according to geological chronology, the beginnings of the various groups. By this means a glance will catch facts which otherwise would demand much reading for their discovery, and probably would be lost sight of entirely unless the reader was very conversant with French. For instance, one sees that the Carboniferous has given the first indication of the existence of Cycads, the primitive Salisburias, etc., while the type Salisburia, or Ginkgo, is not established until the Permian. In the upper Trias we find the ancestors of the Cupressineæ; while in the lowest member of the Cretaceous the first dicotyledons are discovered, and possibly the genus Populus, an appearance which is speedily followed in the upper Cretaceous (Cenomanian) by a great abundance of dicotyledonous types. This

[1] SAPORTA, LE MARQUIS G.—Origin paléontologique des arbres cultivés ou utilisés par l'homme. Pp. xvi. 360. Paris: J. B. Baillière et fils, 1888. Price 3 fr. 50c.

simply serves to illustrate the great amount of information that can be obtained from a table which seems to be packed with details. We commend this book to all botanists interested in the subject, as one which will give them a vast amount of accurate information upon a subject whose literature is widely scattered or hard to obtain.

A Monograph of the Lotus.

Dennert, who completed and edited this posthumous monograph,[2] tells us that Wigand was well known to be an energetic adherent and defender of the doctrine of the fixity of species. He hoped to secure, through the work of his students and others, a series of exhaustive monographs, not only of families and genera, but also of species, in which every character of the plant should be set forth. From such a series of works upon nearly related plants, he hoped to be able to draw important conclusions regarding the value of specific characters, the relations of variation, and particularly to obtain an exact definition of the term "species." As an indication of the sort of work which he wished, he undertook this monograph on a most interesting plant, the famed Lotus. But the work was interrupted and left incomplete at the author's death, and Dr. Dennert, assistant in the botanical institute at Marburg, added the anatomy of the nodes, the leaf blade and its origin from the petiole, etc. The paper discusses the morphology, development and anatomy of every part of the plant, and concludes with biological remarks on the starch in the leaves and rhizome, and on the vegetative and resting conditions of the rhizome. From this it will be seen how wide is the scope of the monograph. Its execution is admirable and the paper may well be taken as the model it was intended to be. This is the exhaustive style of work to which we have exhorted American botanists.

Minor Notices.

THE INSECT RELATIONS of flowers receives a fresh contribution from Mr. L. H. Pammel, who writes of the pollination of Phlomis tuberosa, and the perforation of flowers by insects.[3] Phlomis tuberosa is compared with P. Russeliana, of whose pollination an account is given by Loew, and which it much resembles. On the perforation of flowers Mr. Pammel has collected much widely scattered literature, both on the direct subject and several related ones. The paper is accompanied by a very full bibliography, and will certainly be of much service to students in this field.

PROFESSOR JOHN MACOUN has just distributed the "Endogens" of his catalogue of Canadian plants.[4] Any one familiar with the other parts

[2] WIGAND, ALBERT.—Nelubium speciosum W., eine monographische Studie, vollendet u. herausg. von E. Dennert. (Bibliotheca botanica, heft 11), pp. 67. pl. vi. 4to. Cassel Theodor Fischer. 1888. M. 12.

[3] PAMMEL, L. H.—On the pollination of *Phlomis tuberosa* L., and the perforation of flowers (Contributions from the Shaw School of Botany, no. 1). Pp. 241–277. pl. vi and vii. 8vo. Separate print from the Trans. St. Louis Acad. Sci., vol. v. St. Louis, June 28, 1888.

[4] MACOUN, JOHN.—Catalogue of Canadian Plants. Part IV.—Endogens. (Geol. and Nat. Hist. Survey of Canada.) 248 pp. Montreal: Dawson Bros., 1888.

understands the painstaking work this represents. The detailed enumeration of stations can not but be of vast help, not only to collectors, but in the study of geographical distribution as well. Professor Macoun has availed himself of all possible help from specialists, so that the catalogue contains the most recent changes in nomenclature. This part brings the genera to 737 and the species to 2955.

THE LONG HOPED for continuation of Professor Tuckerman's Synopsis of N. Am. Lichens has appeared, under the editorship of Mr. Henry Willey.[5] The work could not have fallen into more competent hands. This second part was found in a sufficient state of preparation to justify publication, and very little revision has been necessary. The presentation of the large genera Biatora, Lecidea and Buellia will be a great help to our amateur lichen students, large parts of whose collections were very indefinitely named. The genus Graphis is incomplete, but sixteen species being included in this part. Mr. Willey has done good service also in adding, in the form of an appendix, descriptions of N. Am. lichens not found in the Synopsis, but published by Professor Tuckerman in scattered publications which are not easily obtained.

"HOW TO STUDY BOTANY" is the title of a very interesting paper by Dr. T. J. W. Burgess, of Hamilton, Ontario, read before the Hamilton Association.

THE MEDICAL plants of the United States have attracted attention from Rafinesque down. The most recent contribution to this subject is by Dr. Carter,[6] of Waukegan, Ill. The list is a very long one (over 300 species), but only includes those plants whose medicinal properties are definitely known. The work has been carefully done, and forms a very compact reference book for information of that kind.

THE PLANTS of Nantucket are published by Maria L. Owen in a very carefully prepared catalogue.[7] Nantucket county means practically Nantucket Island, and the enumeration shows 586 species of phanerogams exclusive of varieties. Pteridophytes and algæ are also catalogued. The names of the botanists who have assisted the author are numerous and well known, and we may be sure that the catalogue represents a very accurate and exhaustive account of the flora of this island of fifty square miles.

MISS HELEN C. DES. ABBOTT is a very active worker in the comparative chemistry of plants, and her paper on "Comparative chemistry of

[5] TUCKERMAN, EDWARD.—A Synopsis of the North American Lichens: Part II., comprising the Lecideacei, and (in part) the Graphidacei. 76 pp. Sold by Edwin Nelson, Amherst, Mass., at $1.

[6] CARTER, J. M. G., M. D.—A Synopsis of the Medical Botany of the United States. Pp. x. 176. St. Louis: Geo. H. Field, 1888.

[7] OWEN, MARIA L.—A catalogue of plants, growing without cultivation, in the county of Nantucket, Mass. Pp. xii. 87. Northampton, Mass., 1888.

higher and lower plants," in the *Am. Naturalist* for August and September, 1887, has just been distributed as a reprint.

AN ELABORATE study of the structure, development and affinities of Trapella, a new genus of Pedalineæ, is presented by F. W. Oliver in the *Annals of Botany* (June), and now distributed as a reprint. It is a Chinese plant of doubtful affinity, but this study rests it in Pedalineæ, as the only genus of a new tribe. It contains certain structures of great interest biologically. The five handsome double-page plates form a fitting accompaniment to a very fine piece of work.

ONE of the best local catalogues we have seen is that of Middlesex county, Mass., prepared by Messrs. Dame and Collins.[8] Not only is it printed with great care, but contains just the information one desires. In addition to the usual presentation of phanerogams and pteridophytes, it contains the mosses, liverworts, stoneworts, algæ and lichens. Dealing with an old country and one full of collectors, the list must be a very complete one. The summary shows an enumeration of 2 061 species, 1,484 of which are phanerogams, 60 pteridophytes, 156 bryophytes and 361 thallophytes. In a private letter the authors say that the name of Mr. I. C. Martindale was inadvertently omitted from the list of those who had aided in the work.

NOTES AND NEWS.

IN A RECENT fire the Syracuse Botanical Club lost all of its collections, books and instruments.

MR. LESTER F. WARD'S address on "Asa Gray and Darwinism" has just been distributed.

DR. G. F. KOHL, *privat-docent* in Marburg, became associated with Dr. Uhlworm in editing the *Botanisches Centralblatt* on the first of August last.

MR. F. W. ANDERSON, of Great Falls, Montana, has been appointed a special agent in the Division of Botany of the Agricultural Department.

THE *Journal* of the Elisha Mitchell Scientific Society, in its first part for 1888, contains a preliminary list of North Carolina Desmids by W. L. Poteat.

THE ILLUSTRATIONS of our native plants in *Garden and Forest* for August include Cypripedium Californicum (8th), and Erythronium Hendersoni (29th).

M. L. MOROT (in *Journ. de botanique*) shows that the anatomical structures of the anomalous Adoxa Moschatellina are more suggestive of Saxifragaceæ than of Caprifoliaceæ.

[8] DAME, L. L., and COLLINS, F. S.—Flora of Middlesex county, Mass. Pp. 201, with map. Malden: Middlesex Institute. 1888.

REPORTS from the recently established agricultural experiment stations are beginning to come in rapidly. We have before us various kinds of reports from Indiana, Michigan, Illinois and Iowa.

DR. BESSEY (*Am. Naturalist*, June) suggests that the development of chlorophyll-bearing tissue in young fruit is for the nutrition of the embryo in the seed, and remarks that this is an important but overlooked function.

THE LARGE and important collection of fungi belonging to the late Dr. G. Winter has been purchased by the Botanical Museum in Berlin. It is well that this valuable herbarium is to be kept together and be accessible to students.

PROLIFEROUS strawberries are not so common, and the *Gardener's Chronicle* (August 18) figures one that has three or four buds from the sides, one of them so fully organized as to have leaves, adventitious roots, a beginning runner and a terminal flower.

PROF. W. W. BAILEY reports finding recently a fully-doubled Aster, all the disk florets changed into ligulate ones, between Lake Oskawana and Garrison's, N. Y., near Cowpens Mt. The species is probably A. macrophyllus. All the heads on the plant were so doubled.

DR. JOSEPH SCHRENK gives, in the *Druggists' Bulletin* for August, two papers, entitled "Pharmacognostical notes on the bark of Sycocarpus Rusbyi," and "Pharmacognostical notes on the bark of Newbouldia laevis." The papers are illustrated by two admirable figures.

OUR KNOWLEDGE of the plants of the interior of China is rapidly advancing, judging by the rate at which lists and new species are being published. In the *Journal of Botany* (August) Dr. J. G. Baker catalogues two recent collections of ferns, among which are described sixteen new species.

IN LOOKING over Schimper's herbarium at Kew, Mrs. E. G. Britton has discovered a specimen of Ulota phyllantha, labelled in Schimper's own handwriting, "Muckross, Killarney, Hibern.," which bears five capsules. The specimen was collected in 1865. This is a lesson to bryologists to look out always for fruit, even on specimens of species usually sterile.

THE ANNUAL REPORT (for 1887) of the Royal Botanic Gardens at Trinidad has been distributed by their very efficient superintendent, Mr. J. H. Hart. A summary is given of the history of the garden and its present condition. The photographic illustrations are especially interesting, giving one a notion of the beauty and plan of the gardens better than any text.

THE LAST two parts of the seventh volume of the *Annales des Sciences Naturelles* (*Botanique*) are almost entirely devoted to an elaborate paper by M. Courchet on chromoleucites. He discusses their development, structure and form, the relation between the color of a pigment and the form in which it exists, and finally details a special study of the pigments contained in the chromoleucites or produced by the leucites. The memoir gives a host of details, and evinces an extraordinary amount of work. It does not, however, present any essentially new principles, and agrees, in the main, with Schimper's well-known contributions on these and allied structures.

MR. C. E. OVERTON has watched the conjugation of Spirogyra, and finds that the conjugating tubes grow toward each other at the rate of 3μ per hour, and that twenty four hours elapses between their contact and the complete solution of the wall. The passing over of the contents from the male cell usually begins about ten or eleven o'clock at night.

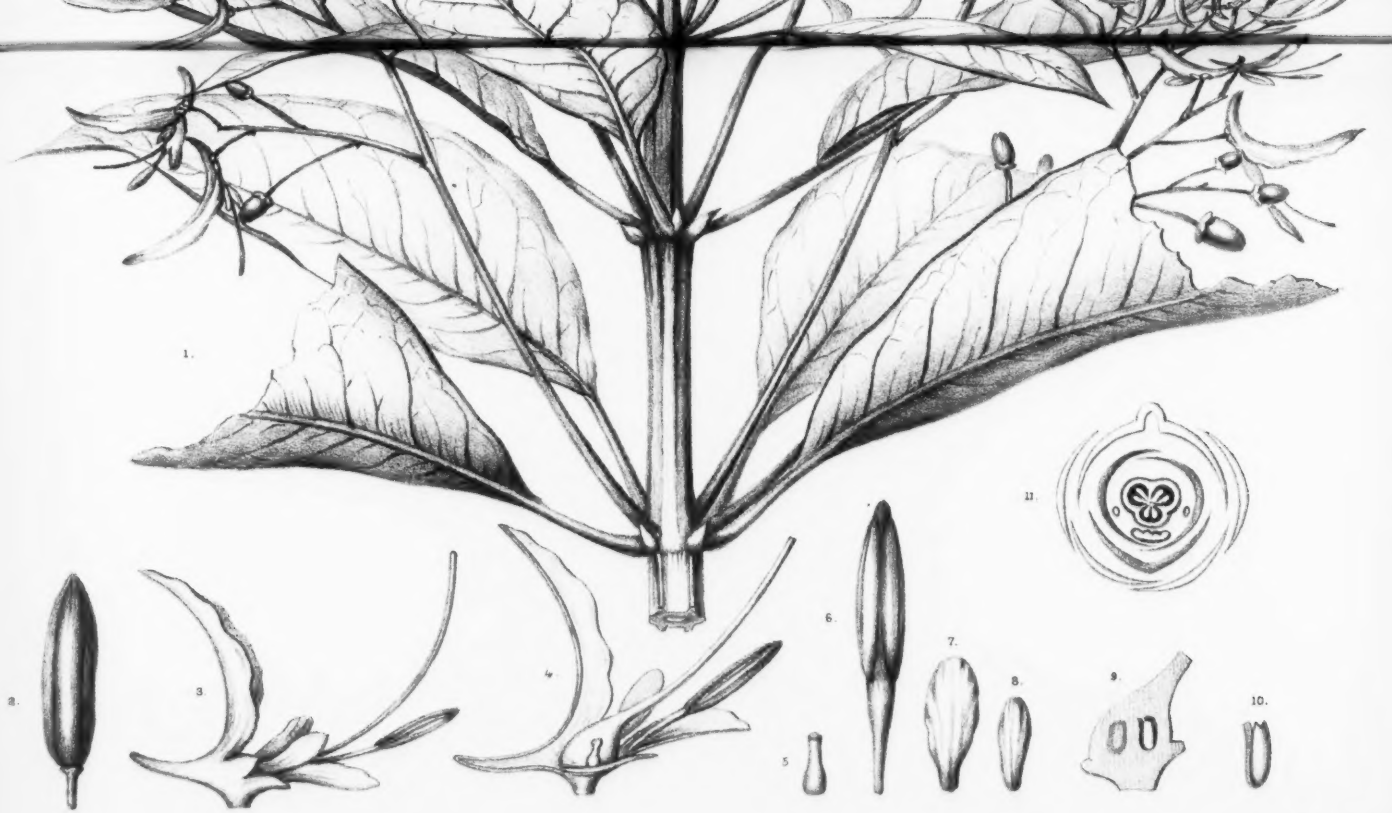
THE NEW GENUS of Palms (BOT. GAZETTE, xi, 314) from the Florida Keys, brought to light by Dr. C. S. Sargent and dedicated to him, is figured in *Garden and Forest* (September 19), where the completed generic characters are also presented. Ripe seed was obtained last year by Mr. Curtiss, and Dr. Wendland has thus been able to establish his Pseudophœnix Sargenti.

IN THE September *Amer. Jour. Sci.* there appears as an appendix a list of the writings of Dr. Gray, chronologically arranged. The work has been done by Drs. Goodale and Watson, assisted by Professors Farlow and C. S. Sargent, and a glance through these forty pages of fine print not only shows the great labor involved in its preparation, but also what an enormously prolific writer Dr. Gray was. Beginning with two numbers in 1834, one on mineralogy and the other the N. Am. Gramineæ and Cyperaceæ (exsiccatæ), and ending with 1888, no year is unrepresented in his writings, excepting 1839 and 1869, and even these contain editorial work. No less than 355 numbers are credited to him, besides the uncounted number of botanical notices and book reviews.

THE memorial of Asa Gray at the American Academy of Arts and Sciences has been distributed and should be in the hands of every American botanist. The resolutions were offered by the president, Prof. Joseph Lovering, and seconded in a short address by Mr. Augustus Lowell. President Eliot then spoke briefly of his relations to Harvard University. The chief interest centers about the addresses of his botanical associates, those men who did not know him afar off, but were in daily contact with him. Dr. Goodale spoke chiefly of him as an instructor, in the lecture room and through his books. Dr. Watson naturally had to deal with his relations to the great herbarium which bears his name; while to Dr. Farlow fell the more onerous duty of preparing a biographical sketch. When it is said that all of these addresses were worthy of the man they had met to honor no higher commendation is needed.

F WENT has in the last part of Pringsheim's *Jahrbücher für wissenschaftliche Botanik* (vol. xix, pp. 295-356) an exceedingly important paper on vacuoles. His conclusions, in his own words, are as follows: With the exception of the doubtful spermatozoids, Cyanophyceæ, and Bacteria, all living cells contain vacuoles which are surrounded by a special living wall which bears the name of "tonoplast." In all young cells division and coalescence of vacuoles takes place. All normal vacuoles of a plant arise through continual division from those of the oosphere. The tonoplasts, considered as organs of the protoplasm, are of equivalent origin with the nuclei and chromatophores. Since the vacuoles, even in the youngest cells, are continually altering their shape, protoplasmic movement must take place in them, and does not begin, as Hofmeister thought, only after the meristematic state is past. Normal vacuoles never arise from the protoplasm. Pathological vacuoles are formed by the disorganization of the nuclei and chromatophores. The paper concludes with a summary of the present knowledge in regard to the vacuoles.

VOCHYSIA GUATEMALENSIS, J.Donnell Smith.



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VOCHYSIA GUATEMALENSIS. J.Donnell Smith.

G. L. Paxton del.

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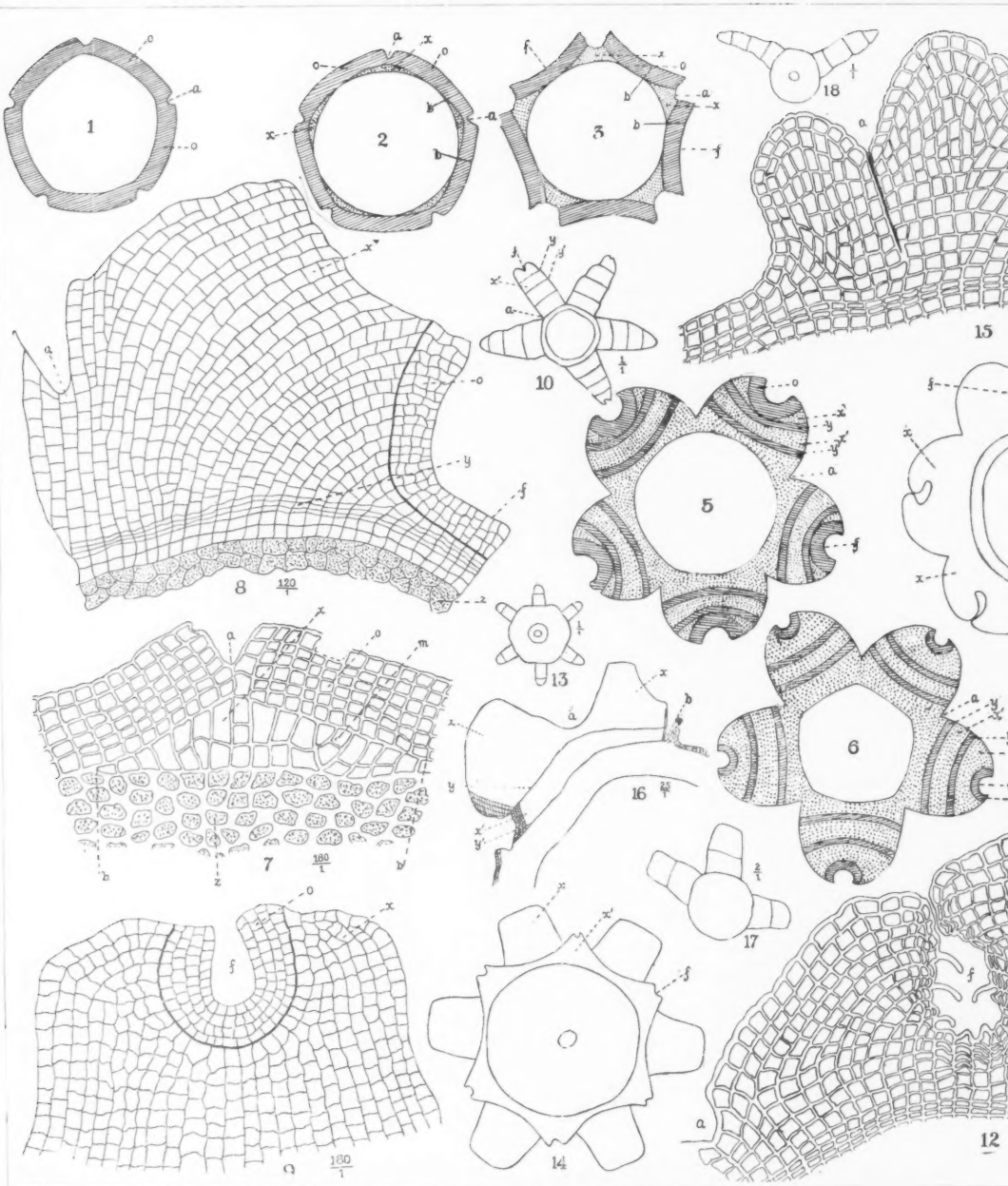
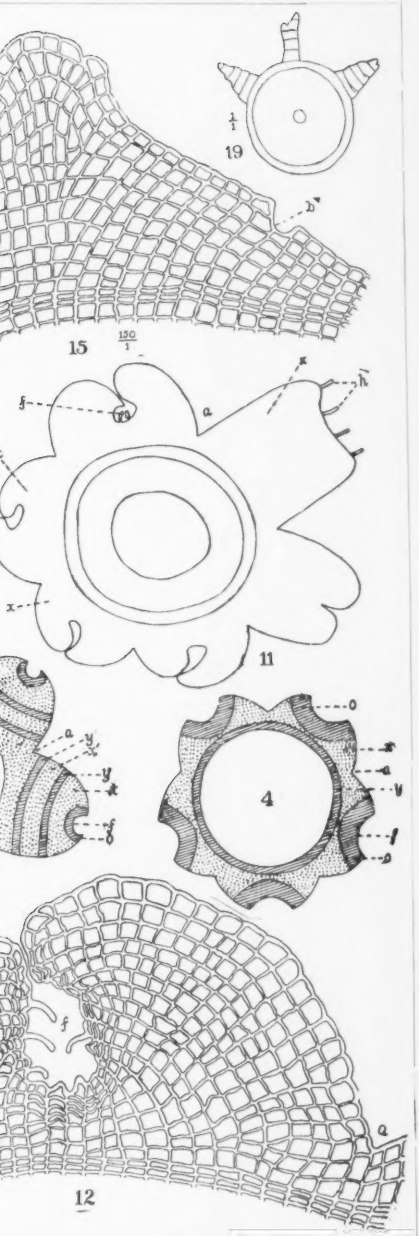
PITCAIRNIA TUERCKHEIMII, J Donnell Smith.



GREGORY ON DEVELOPMENT OF CORK WINGS.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